SHUFFLE METHODOLOGICAL DECKCHAIRS OR ABANDON THEORETICAL SHIP?

THE COMPLEXITY TURN IN INJURY PREVENTION

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Introduction

Injury prevention theory, research, policy, and practice has provided a rich basis for the consensus that injuries are not unavoidable 'accidents', but rather the result of predictable and preventable events.[1-8] Yet, unintentional injuries remain a leading cause of morbidity and mortality worldwide.[9] Thus, there remains a persistent global burden of injury that appears resistant to the efforts of conventional science, and a growing recognition that injury is a complex problem requiring complex solutions.[10-12]

The move to systems thinking

In response to the recognition of this complexity, recent authors have noted the advantages of systems thinking approaches to injury prevention research.[13-15] This shift holds that intrapersonal, interpersonal, organisational, community, and societal determinants combine together into a highly complex 'web of determinants' that influences the likelihood of injury occurrence.[13-16] Systems thinking thus offers much promise for further improvements in understanding injury and its prevention as a complex problem.

The move to systems thinking is a promising one. However, the growing support for systems thinking as a valid way to approach complex, intractable injury problems has an unintended unhelpful consequence. This being an over-emphasis on the epistemological question of how multifactorialism is accounted for in research, and a corresponding under-emphasis on the ontological considerations and assumptions we make about the world.

This dissonance in how complexity is understood and applied has been explored in a recent systematic review of systems thinking approaches in public health – which concluded that: 1) close to half the papers identified by the review process are commentaries, 2) systems thinking in public health suffers from methodological weaknesses that need to be addressed, 3) much systems thinking in public health assumes a positivist and linear view of policy, and 4) success in systems thinking in public health is evaluated/defined on the basis that it is present, not that it is effective.[17] This clearly echoes the sentiment of Eriksen and colleagues[18(p9)], in that: "to move from monocausality to multifactorial causation does not in itself guarantee that we take the complexity seriously". This is not necessarily because of an inadequate toolbox of methods, as is often (mis)understood by the call for a move to complex systems thinking; rather, it is the prevailing tendency of contemporary injury research scientists to see the world inadequate explanatory philosophical frameworks for complex injury issues and their solutions. Indeed, McClure[19(p177)] states that "without an explicit understanding of the common conceptual underpinnings of injury prevention in all its contexts, there is no platform from which to drive change".

The current shift to systems thinking thus appears to be more about shuffling of methodological deckchairs, when what is really needed is an abandoning of theoretical ship, ideally for a sturdier vessel. This is because some attempts at incorporating systems thinking into injury prevention research have made the mistake of merely dividing complex problems up into parts, and then studying the relationships between those parts.[20] As Ericksen and colleagues[18(p9)] further theorize: "If our methods are designed to treat each factor separately, the phenomenon as a whole is lost even if we include many factors and add them up".

While many injury prevention research questions have been answered, the scope of these questions has, in this way, been constrained by our scientific approach, and our ability to make dramatic injury prevention improvements is limited, not enabled, by the science we undertake [21]. I believe the next true shift to understanding injury problems through a complex systems lens will be solved less by increasing methodological sophistication, and more by shifting the basic premises and frameworks in our thinking about the way the world works. A shift that may, ultimately, change the kinds of research questions we ask, and the types of problems we seek to solve.

Bringing in complexity

Research does not occur in a philosophical vacuum. Key assumptions - whether explicit or implicit – are coupled with the types of knowledge we seek. In moving to complexity approaches in injury prevention research, a different lens is now necessary.

The origins of complexity theory are traced in Castellani & Hafferty's[22] 'Map of the Complexity Sciences'. This map shows the rich, varied, and continually emerging history and development of this approach. The argument presented here draws primarily from the development of *social complexity* meta-theory,[20, 22-30] as well as complexity theorists working in health sciences, including Plsek & Greenhalgh,[31] Clark,[32] Hawe,[33] Braithewaite and colleagues,[34] and the new collection on international perspectives on complexity in health systems from editors Greenhalgh and Papoutsi.[35] Complexity theory has thus emerged as an approach by which to explore what surfaced as the limitations of conventional reductionist approaches.

In moving from conventional to complexity approaches in injury prevention research, how we understand the application of complexity is key. As Boulton, Allen & Bowman [20(p27)] argue, complexity on this understanding "is not a model or a method or a metaphor, it is a description of the way things are". Thus, it should not be seen as a pure theory as such, but a framework or lens.[22]

Understanding complexity

A helpful way to understand the place of complexity in the spectrum of scientific thinking is illustrated in Table 1.[12, 20, 25, 28, 34] Science can be classified as either simple (recipe-like) or complicated (containing subsets of simple systems), or complex (where the whole is equal to more than the sum of its parts). It is, therefore, useful to view the complex approach as being a way to scaffold our research that is fundamentally different from complicated approaches, not just meaning *very* complicated.

Table 1: A comparison of simple, complicated, and complex problems (Adapted from Glouberman and Zimmerman [28(p22)])

Simple	**Complicated**	**Complex**
Baking a cake	*Sending a rocket to the moon*	*Raising a child*
Recipe essential	Formulae critical and necessary	Formulae have limited application
Recipes tested to assure easy replication	Sending one rocket increases assurance that the next will have a	Raising one child provides experience but no assurance of

	good chance of success	success with the next
No particular expertise required but cooking expertise increases success rate	High levels of expertise in a variety of fields necessary for success	Expertise can contribute but is neither necessary nor sufficient to assure success
Recipes produce standardized products	Rockets similar in critical ways	Every child is unique and must be understood as an individual
The best recipes give good results every time	High degree of certainty of outcome	Uncertainty of outcome remains

Working in, with, and through complexity

Understanding injury as a complex problem provides a useful lens by which to understand the lack of progress in some areas of injury prevention.[12] Working with complexity has important implications for the kind of knowledge that is privileged and, in turn, the research questions formulated, methods used, data collected, and outcomes elicited.

The relevant three key tenets for injury prevention [Figure 1], as collated by Bekker and Clark,[12] are well-placed to inform the ways in which injury research questions can be formulated to better account for complexity. The complexity tenets - open systems (stratification and fluidity), non-linearity (emergent properties and feedback loops), and improbability (demi-regularities and the ability to evolve, learn, and adapt) – thus provide a manner of scaffolding injury prevention as inherently complex [Table 2].[12] Complexity, on this view, is congruent with qualitative,

quantitative and mixed-methods approaches, determined by research question rather than methodological predilection. Rather than focusing on method, research studies and interventions for complex problems should thus be focused on understanding system goal behaviour using methodological pluralism to better explain both positive and negative outcomes.[34]

<Insert Figure 1 here>

Table 2: Complexity, its implications, and recommendations for future injury prevention research

Complexity tenet	**Implications**	**Recommendations for future research**
Complexity approach	Generation, identification, and explanation of new types of knowledge that holds the world as inherently complex (rather than simple or complicated)	Recognise the world as inherently complex More relevant research questions making use of qualitative, quantitative and mixed-methods approaches
Provided in open systems	Interventions are influenced by context which is fluid and in flux, as well as potentially many other non-intervention factors	The limitations of randomised controlled trials and ecological randomised controlled trials should be acknowledged, and more relevant research methods considered
Have stratification	A complex interplay between the individual and their behaviour, as well as the physical and social environment	Interventions must be described comprehensively and the interactive, generative effects of components better understood

Demonstrate fluidity	Stratified open systems are always *becoming* and are thus in flux	Understand the interconnection and impermanence across stratification and within open systems Accept fluctuation as a norm, and embrace inherent diversity (heterogeneity) as a key feature of complexity
Have non-linearity	Interventions affect outcomes indirectly	The multi-faceted, fluid and flux nature of interventions and their contexts must be accounted for, researched, and better understood
Have emergent properties	Interventions can create powers not inherent in the intervention itself The whole is more than the sum of its parts, and irreducible to these parts	The manner in which interventions generate powers which affect outcomes needs to be recognised and elicited
Have feedback loops	Interventions affect themselves, and re-organise future actions	Interventions must be described comprehensively and the interactive powers and effects researched and understood, particularly over time and across space
Demonstrate improbability	Intervention outcomes are uncertain, and in some cases unintended, unpredictable, and unknown. However, even if outcomes are uncertain, they are not likely to be entirely random	Instead of controlling for improbability, a complexity lens provides contingencies for facilitating better understandings through studying demi-regularities, and the ability to evolve, learn, and adapt
Produce demi-	Intervention outcomes should be understood as somewhat	Relinquish focus on the false dichotomy of whether an intervention

regularities	patterned	'works' or 'doesn't work' A better, more relevant question is: What works, for whom, when, why, and how?
Evolve, learn and adapt	Interventions work differently and have different effects over time	Multiple follow-up evaluations are needed to understand the various ways the intervention affects outcomes

Conclusion

Complexity is ubiquitous. A key strength of a complexity lens is that it provides the language by which a different manner of thinking about the ways in which the word works, and ways of being within the world can be explained. This allows implicit assumptions to be made explicit, which, in turn, allows for complexity to be embraced. Drawing on complexity theory as a means of scaffolding the world allows us to better uncover how this perspective can be applied to the field of injury prevention research, so as to ultimately suggest ways in which intractable problems can be confronted in new and exciting ways.

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Figure 1: Tenets of a complexity approach to injury prevention research (adapted from Bekker and Clark12).